Al Mashtal Development

Preliminary Environmental Report

Prepared by:

P.O. Box 94288
Abu Dhabi
United Arab Emirates

T +971 2 681 2944
F +971 2 681 3944

For:

Sorouh Real Estate
P.O. Box 93666
Abu Dhabi
UAE

T +971 2 444 0006
F +971 2 444 0066

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Mouchel	Nassir Eltinay	1 x electronic
Sorouh	Nabil R. Akileh	1 x electronic

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We have used our reasonable endeavours to provide information that is correct and accurate and have discussed the reasonable conclusions that can be reached on the basis of the information available. Having issued a range of conclusions as part of this report it is for the client to decide on the implementation and next steps.

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1 Introduction

1.1 Proposed Project

Sorouh Real Estate is planning to develop a mixed-use scheme on the site, known as Al Mashtal, which consists of residential, retail, office and entertainment elements as well as a *5,000* capacity arena.

Mouchel has been contracted to investigate, manage and report on the relevant local and sub-regional engineering (utilities, infrastructure, civil engineering and environmental engineering) and transportation constraints and opportunities of the Al Mashtal development project.

1.2 Purpose and Scope of the Preliminary Environmental Report (PER)

Following a review of the Environmental Application Permit by Abu Dhabi Environment Agency (EAD) for the proposed project, a decision to provide a PER was requested to identify the key environmental issues associated with the development and identify potential constraints and opportunities.

This report provides information to support the design elements of the development to assist in decision making and to ensure that the environmental and sustainability impacts are minimised and enhanced where feasible.

Specifically the objectives of the PER are:

- To determine whether the project may produce significant adverse environmental impacts and if mitigation measures can be adopted to reduce or eliminate such adverse impacts.
- To inform the client of the main environmental constraints and opportunities at this current design stage.
- To form the basis for constructive discussions within the design team and, if necessary, planning authorities on the environmental and sustainability implications of the development.
- To ensure all applicable environmental regulations and standards are met in the proposed development.
- To provide a summary of the environmental permitting process including the process for determining the required level of environmental assessment and reporting to gain the Environmental Construction and Operating Permit, issued by Abu Dhabi Environment Agency (EAD). (Note a full assessment would require the production of an Environmental Impact Assessment and Construction Environmental Management Plan).

1.3 Statement of Need

The Al Mashtal project presents a unique opportunity to create a landmark development in the centre of Abu Dhabi. In order to do that, it must combine a commercially viable content with efficient and functional planning, as well as a memorable and iconic architecture, and a responsive, communal urban fabric.

Abu Dhabi has a vibrant property market and several major new developments are underway increasing its commercial prosperity. Therefore it is important for Al Mashtal to distinguish itself by an integrated mixed–use design with key retails,

commercial and residential towers, together with a very first public arena, to be built in Abu Dhabi's prime location, which can become a brand new landmark and symbolic development for Abu Dhabi.

1.4 Environmental Process

There is a clear Environmental Permitting Process operated through the Abu Dhabi Environment Agency (EAD). The Process addresses the required level of environmental assessment and reporting required for the issue of an Environmental Construction and Operating Permit by the EAD.

There are 4 key stages to the Process:

1. Screening - Environmental Permit Application.
2. Scoping - Terms of Reference.
3. Reviewing - Environmental Impact Assessment and Construction Environmental Management Plan.
4. Monitoring – Pre-commissioning audit and issue of Environmental Operating Permit.

1.5 Statutory Requirement for an EIA

1.5.1 Law No. 24 (1999) – Protection and Development of the Environment

Federal Environmental Law No. *24/1999* for the Protection and Development of Environment relates to the need for environmental studies to be conducted for new and existing developments. Law *24* was passed by H. H. Sheikh Zayed in October 1999 and came into effect in February *2000*. From *2002* it is a statutory requirement and is enforced by the Abu Dhabi Environment Agency (EAD).

Law *24* stipulates the need to assess the environmental implications of developments as well as the level of environmental assessment (i.e. Preliminary Environmental Review and EIA).

The Law seeks to:

- Protect the environment; preserve its diversity and natural equilibrium.
- Fight all forms of pollution and avoid harmful immediate or long-term adverse effects resulting from planning for economical, agricultural, industrial or constructional development or any development programmes aiming to upgrade the standard of living.
- Develop natural resources and preserve the various living species in the UAE and utilise them in an optimal way for the benefit of present and future generations.
- Protect society, the health of human beings and other living creatures from any activities or acts which compromise a risk to the environment or which impede the lawful use of the environment.
- Undertake the implementation of international and regional conventions ratified or signed by the state in respect of environmental protection, pollution prevention and preservation of natural resources.

1.6 EIA Process

The EIA process is clearly defined by the Guidance "Standard Operating Procedures for Permitting of New Projects and Activities in Abu Dhabi" published by the the Abu Dhabi Environment Agency (EAD) (formerly the Environmental Research and Wildlife Development Agency). Figure 1.6-1 shows a flow chart which summarises the permit issues procedure.

1.6.1 Environmental Permit Application

The first phase in the permitting process is the submission by the project proponent of an "Environmental Permit Application for Construction of Project/Facility" form to the EAD. The EAD then reviews this form and makes a decision to either issue a one year "Conditional Environmental Permit (CEP)" or require a "Preliminary Environmental Review (PER)" study to be undertaken.

CEPs are issued with conditions and monitoring of construction activities will be undertaken to ensure compliance with these set conditions. The PER must be undertaken in accordance with EAD guidance and standards.

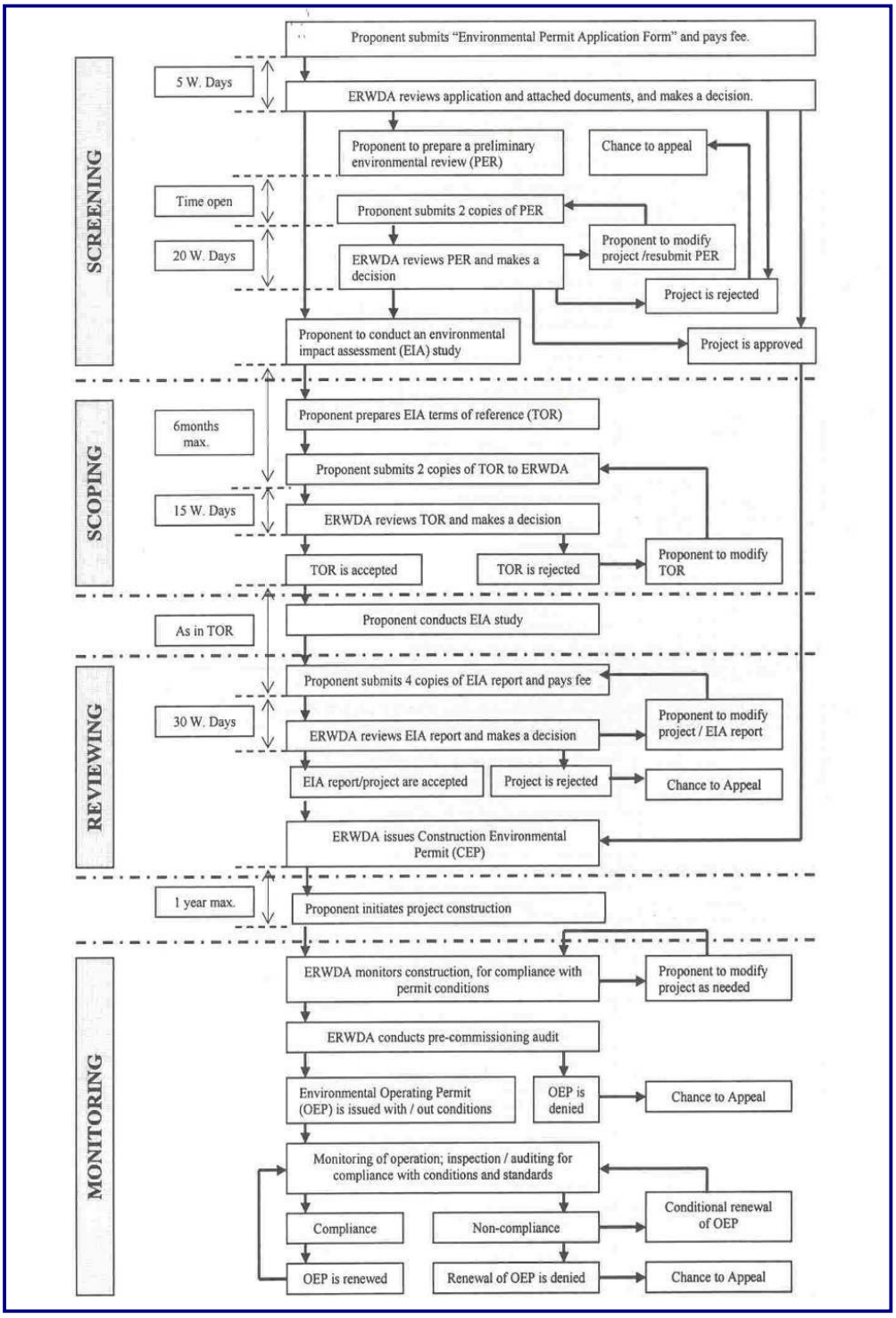

Figure 1.6-1: Flowchart of Permit Issue Procedures

1.6.2 Preliminary Environmental Report

A PER detailing the key environmental constraints may be required to assist in EAD's decision-making process. If the PER study is deemed sufficient then the EAD will issue a CEP. If the PER study is deemed insufficient then the EAD will instruct the project proponent to initiate the EIA process.

1.6.3 Terms of Reference

The first phase of the EIA process is the preparation of a "Terms of Reference (TOR)" report. The TOR report is also sometimes referred to as the "Scope of Works". Annex *8* of the EAD guidance defines the content of a TOR report.

When preparing a TOR report project proponents should have regard for the EAD guidance on EIA format "Format for the Submission of Environmental Impact Assessment Reports" which the TOR will need to set the framework for.

Once the proponent submits the TOR report to the EAD they have *15* working days to make a decision. If the TOR is accepted the proponent can proceed with the EIA, if the TOR is rejected it will need to be modified and re submitted.

1.6.4 EIA

On approval of the TOR the proponent can commence an EIA. The EIA will develop and expand on the information and plans detailed in the TOR, detail survey and monitoring results as well as incorporating feedback and requirements from EAD. The report will be produced in accordance with the EAD guidance on EIA format "Format for the Submission of Environmental Impact Assessment Reports".

1.6.5 Construction Environmental Management Plans (CEMPs)

CEMPs may be required where an EIA has determined that, following consideration of mitigation measures, the development would have a residual adverse impact on the environment. Once the EIA has been approved and the project has been granted planning permission, a practical plan of construction in the form of a CEMP is required.

CEMPs aim to determine how construction should be managed in order to minimise potential environmental impacts. Producing the CEMP is the responsibility of the development contractors. For further information on CEMPs and the management of construction phase environmental impacts see section *5.2*.

1.6.6 Monitoring

Monitoring requirements will be determined within the EIA and from any feedback from the EAD review and approval process. EAD will monitor construction of the project to ensure that these monitoring requirements are undertaken as well as ensuring compliance with any conditions set.

2 Project Description

2.1 Vision of the Proposed Development

The proposed development aims to provide a landmark development in the centre of Abu Dhabi combining a commercially viable content with efficient and functional planning, as well as memorable and iconic architecture and a responsive, communal urban fabric.

Figure 2.1-1: Proposed Vision of Al Mashtal

2.2 Introduction to the Proposed Development

The proposed development covers a site of approximately *135,000* m^2 and consists of a mixture of office, residential, retail and entertainment facilities including a *5,000* seat arena, high specification gym, swimming pool and sports club. The parking requirement is for approximately *5,190* cars.

It is a linear site which is split into 3 main components – office strip to the north, retail, residential, hotel strip to the south, a multi-purpose arena and public plaza at the centre.

Table 2.2-1 indicates the key facilities within the development.

Table 2.2-1: Al Mashtal Proposed Facilities

Component	Quantity	Levels	GFA (m^2)	Parking Spaces
Office towers	5	33, 29, 25, 22, 17	180,400	2,760
Entertainment block	1		16,500	180
Serviced apartment tower	1	33	48,950	218 (inc. hotel)
Residential towers	3		86,050	832
Hotel	1	14	22,960	(as per serviced appt tower)
Retail			66,000	1,200
Arena (including 2000m2 of Fitness Centre)	1	(5,000 seats)	11,700	(use of office towers parking)
Total number of parking spaces				5,190

In addition, there will be the supporting transport infrastructure such as the widening of the main road and paving, landscaping features such as fountains, sculpture tower, open spaces and plazas.

The total GFA (Gross Floor Area) is *432,560 m^2*. The proposed development footprint covers *75 %* of the site. It is intended that the site will be operational by *2010*.

More detailed information about the proposed development is presented in the Al Mashtal, Abu Dhabi Concept Design *30.01.2007* and the Al Mashtal, Abu Dhabi Concept Design DRAFT Architectural Drawings *28.06.2007*, Sorouh / Arquitectonica.

2.3 Location

The site is situated in the city centre of Abu Dhabi, which is located in the Southern Arabian Gulf. Figure 2.3-1 highlights the location of the site within Abu Dhabi.

Figure 2.3-1: Satellite Image of the Site in Abu Dhabi City

2.4 Current Operations

The site is currently occupied by the Abu Dhabi Municipality, Agriculture Section, and is an agricultural research facility. The site supports the Al Manhal nursery and the Agriculture Research Laboratory. It is covered in trees and plants, some planted, others wrapped in plastic bags for future planting, with a few supporting buildings (administration, staff facilities and water tanks). It is understood that it is not open to the public but is one of the few areas of open space within the City.

Figure 2.4-1: Satellite Image of the Site

Figure 2.4-2: Al Mashtal Nursery Entrance

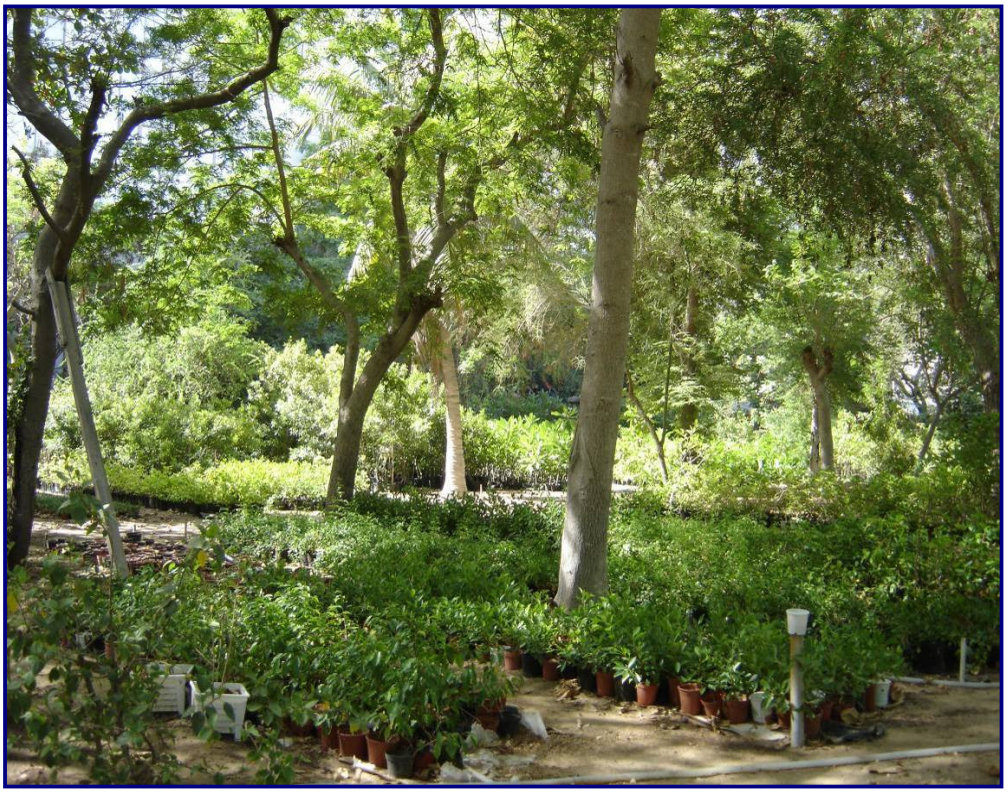

Figure 2.4-3: Various Flora and Features of the Site

2.5 Surroundings

The site is situated opposite the Palace and its associated gardens which it has been proposed should be refurbished and made into a national museum.

Figure 2.5-1: Entrance to the Palace and its Gardens

There are also numerous offices and residential accommodation that overlook the site as well as a number of retail and restaurant facilities. There is a mosque just outside the site boundary.

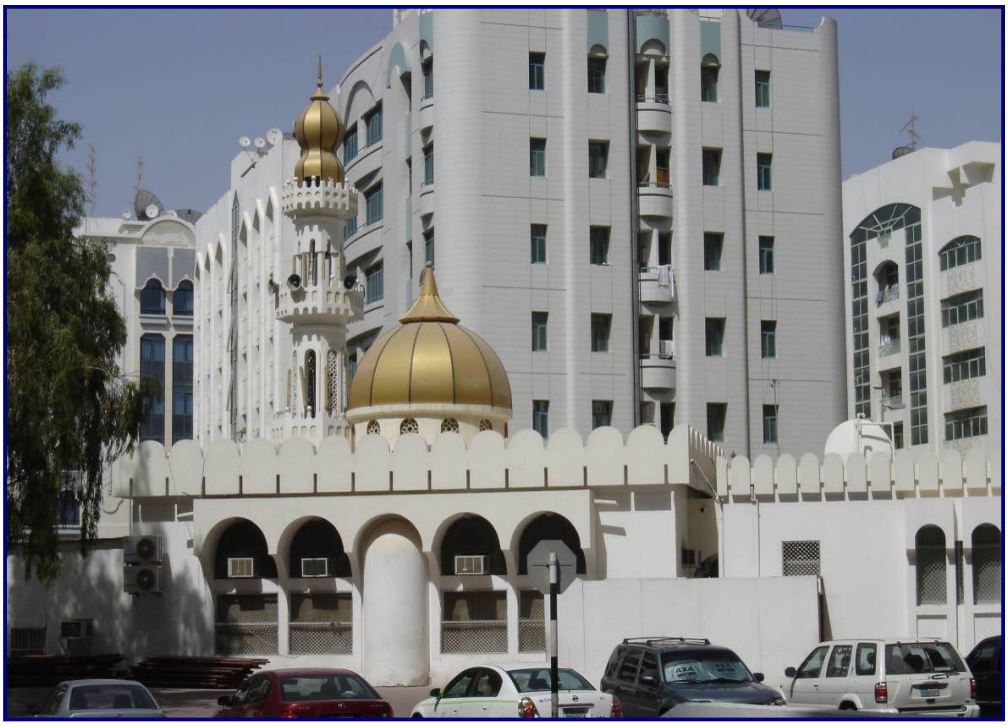

Figure 2.5-2: Nearby Mosque

3 Environmental Baseline Conditions

The environmental baseline conditions has been determined through a desk based study, a site visit, a review of existing available documentation, maps and consultation with relevant parties involved in the project and its development.

The site visit was undertaken on the *5th* June *2007* to identify current site operations, local ecological value, landscape value and the townscape/visual aesthetics.

This section aims to highlight the key constraints, opportunities and design considerations which can be used as an action plan for further design, planning and environmental assessments.

3.1 Topography and Geology

The site covers an area of *135,490 m²*. There have been no topographical surveys of the site to date. The topography was observed to be low and flat. There are a number of trees and small buildings on the site.

The Geotechnical Commentary Report produced by Arup, *May 2007*, includes the following on the site's probable geology:

"Information from a project in the vicinity showed that in the past, the area was backfilled twice and expected to find two different gradation of fill to a depth of about *6* to *7 m*. Fill is underlain by interbeded sandstone and calcerenite and gypsum occasionally. Mudstone can be encountered at a depth of about *17 m*.

Cavities might exist within the rock; however there is no evidence to support this suspicion. The geology would need to be further investigated with a site specific Ground Investigation or a more detailed search of existing records for nearby buildings." (Geotechnical Commentary Report, Arup).

3.2 Water

3.2.1 Groundwater

The Geotechnical Commentary Report states that groundwater is expected to be at a depth of about *2 m* below grade. There are potential impacts to the levels and quantities of groundwater caused by abstraction and dewatering operations from both the construction and operation stages of the development.

3.2.2 Water Bodies

The proposed development is sited approximately *1 km* inland and there are no water courses either on the site or in the vicinity. As such, the proposed development is not considered likely to impact on water bodies.

3.2.3 Water Consumption

Abu Dhabi's daily domestic water consumption rate of *350 litres* per person is one of the world's highest domestic water consumption rate (*SOE, 2006*). The chart below indicates the water consumption per sector.

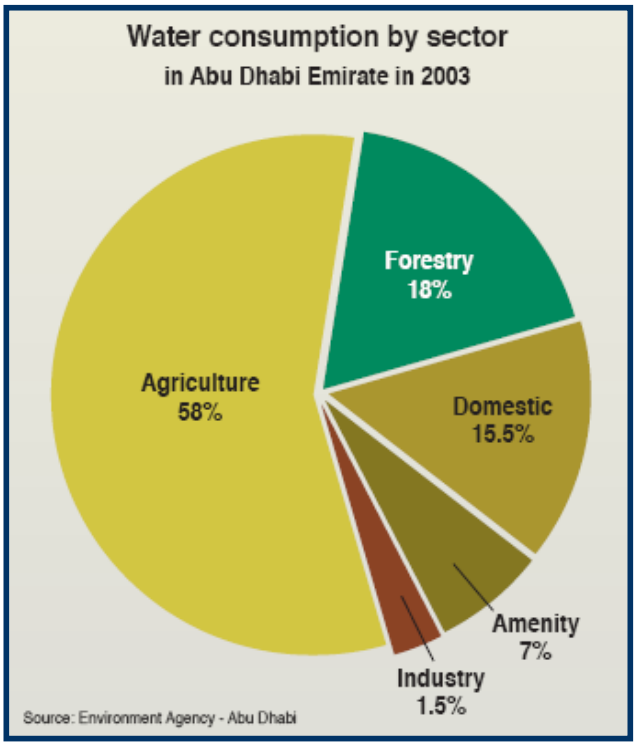

Figure 3.2.3-1: Water Consumption by Sector in Abu Dhabi, 2003

Groundwater is the main source of all water used in Abu Dhabi at approximately *80%* of supply. Abu Dhabi water policy is changing to ensure that demand management is improved and achieve efficiency gains in consumption. The cost of water is therefore likely to increase (note that one of the priority actions within the SOE, *2006* report is to increase tariffs to curb water waste and reduce per capita consumption). The implementation of water efficient measures at this stage could potentially save money in the long term.

The proposed development should look to minimise water consumption and its associated costs during construction and operations where possible.

Water efficiency measures such as the capture of waste water for reuse and use of recycled/grey water have been identified and discussed in Table 5.2-1 section *5*.

Potential impacts to the levels and quantities of groundwater caused by abstraction and dewatering operations from both the construction and operation stages of the development should be investigated fully prior to development.

3.3 Ecology and Biodiversity

Al Mashtal is the one of the last remaining green, open spaced area left in Abu Dhabi providing a unique wildlife sanctuary. The site occupies an area of *13.5* hectares and has over *3000* trees varying in age, species and size with some over *50* years old, reaching heights of up to thirty metres. There is a great variety of fruit trees including fig, date, mulberry, lemon, banana, grapefruit and mango, many of which provide fruit all year round.

These trees provide essential nesting, breeding and feeding resources to a great number of birds, reptiles and invertebrates including the Crowned Honey Buzzard sighted on the field visit. Note that a full ecological survey has not been undertaken to date and therefore the results can not be considered as conclusive.

A tree survey was carried out over two days on *17th – 18th October 2007* at the proposed site to record data on the number, species, size and condition of the trees and to determine the suitability of particular trees for retention or transplanting. Two-thousand standing trees were surveyed over three site locations on the development, *36* tree species were identified, the majority being fruit trees (e.g. olive, grapefruit, fig and banana).

In the tree survey report (Section *8, 8.3.2*) each of the surveyed trees were classified into four categories to identify the quality and value of the existing tree stock, allowing informed decisions to be made concerning the trees which should be transplanted or removed from the site.

The existing trees of good quality and of appropriate species and positions can greatly enhance and add to the quality of a new development and increase property values. Mature trees provide an immediate appearance of maturity and permanence and vertical interest. They provide many benefits to the surrounding area including shading from extreme temperatures, absorption of carbon dioxide and provision of wildlife habitats.

The survey identified the trees suitable for transplantation to other locations and the trees that can be removed; none of the trees will be retained on the site. Lists of the trees that will be removed and transplanted to another nursery are highlighted in Section *8, 8.3.3*. In order for tree transplantation to be a success and to ensure that the trees survive, the guidelines on tree transplanting in the Tree Survey Report (Section *8; 8.4*) should be carefully followed.

There are also a variety of trees within the road corridors surrounding the site which include the UAE native “Ghaf” tree. Local and international conservation bodies launched a campaign in *2006* to protect the endangered Ghaf tree and are currently raising public awareness to designate it as the UAE’s national tree (URL 1). Landscape plans are currently been undertaken to design these trees as distinct landscape features that will help enhance the road corridor of the proposed development. As well as the Ghaf tree there are a variety of species within the road corridor which are suitable for transplanting. In the event that these trees do not impact on the development, steps should be taken to retain and protect as many of these trees as possible.

The development should incorporate an area of open space using the existing mature vegetation and could provide an opportunity for education and raising local awareness. Where this is not possible, enhancement of an ecological site of local or national importance should be supported in order to compensate for loss of ecological value resulting from development of the site.

3.4 Landscape and Visual

The site has a low landscape dominated by trees and small buildings. It can be identified as an urban ‘green’ open space. The site can be considered as aesthetically pleasing.

The proposed development will significantly alter the current townscape and visual appearance with an increase in city aesthetics including high-rise buildings and large retail/entertainment buildings. The buildings will be dominant features on the sightline. There maybe an increase in shading, the formation of micro-climates and the occurrence of wind tunnels. These effects should be determined through further assessment as detailed design proceeds.

The proposed architecture may increase the land value by enhancing the city environment by creating iconic design features, increasing facilities, improving the character of public realm and constructing new tourist attractions.

Figures 3.4-1 and 3.4-2 demonstrate the significant change to the land/townscape.

Figure 3.4-1: South East Elevation of the Proposed Development

Figure 3.4-2: Aerial View of the Proposed Development

3.5 Air Quality and Climate Change

The main source of air pollution within Abu Dhabi is from the oil and gas industry followed by the power and transportation sectors. Traffic related air pollution includes sulphur dioxide, nitrogen oxides and particulate matter which are some of the pollutants causing the most concern. In particular, nitrogen dioxide levels have increased and now exceed air quality guidelines in the city centre (SOE, *2006*).

At present there are minimal operations on the site that emit greenhouse gases into the atmosphere, in fact the number of trees on the site can be considered beneficial in this regard.

The proposed development will increase air pollution levels during the construction phase (primarily dust and through construction transportation) and during its operation through the indirect increase in local traffic from users, visitors and servicing. The proposed site facilities such as the accommodation towers, office blocks, retail and the arena will also require significant quantities of energy for operations such as lighting and air conditioning.

Energy efficiency measures incorporated within the design of the building will help reduce energy consumption levels and the associated impacts. The development should also ensure there is appropriate provision for the use of public transport and encourage more sustainable modes of transport such as walking and cycling.

In order to assist with the preservation of resources and minimise pollution the use of renewable energies such as solar power should be explored, energy and water efficient designs should be adopted and waste should be minimised and reused.

3.6 Noise

Current noise levels are low due to minimal site activities. There is surrounding noise from traffic, retail, construction and other daily human activity.

Construction of the proposed development will generate noise and vibration from numerous sources. These will include traffic, materials unloading and handling, piling, earthworks and operation of heavy plant.

There will be elevation in noise levels from increased traffic and the retail and entertainment facilities during the operational phase. In particular, late night noise will increase due to the proposed arena, the increase in the number of people and other operations such as air-conditioning units.

The nearest sensitive receptors will be the Abu Dhabi City residents, workers and the nearby mosque.

3.7 Archaeology and Local Heritage

Development of Abu Dhabi over the last few years has put pressure on its cultural heritage and plans are in place to ensure surviving features are protected.

The map below (Figure 3.7-1) indicates the sites of major archaeological importance within the Abu Dhabi Emirate.

The archaeological history of the site is currently unknown although the development is located on reclaimed made ground which is unlikely to support any important archaeological features. There are a number of heritage features close to the site including the neighbouring palace and mosque which will need to be protected from disturbance. Consultation with the Abu Dhabi Authority for Culture and Heritage should be progressed further to help identify whether there are any known archaeological or heritage features on or near the site that may be affected.

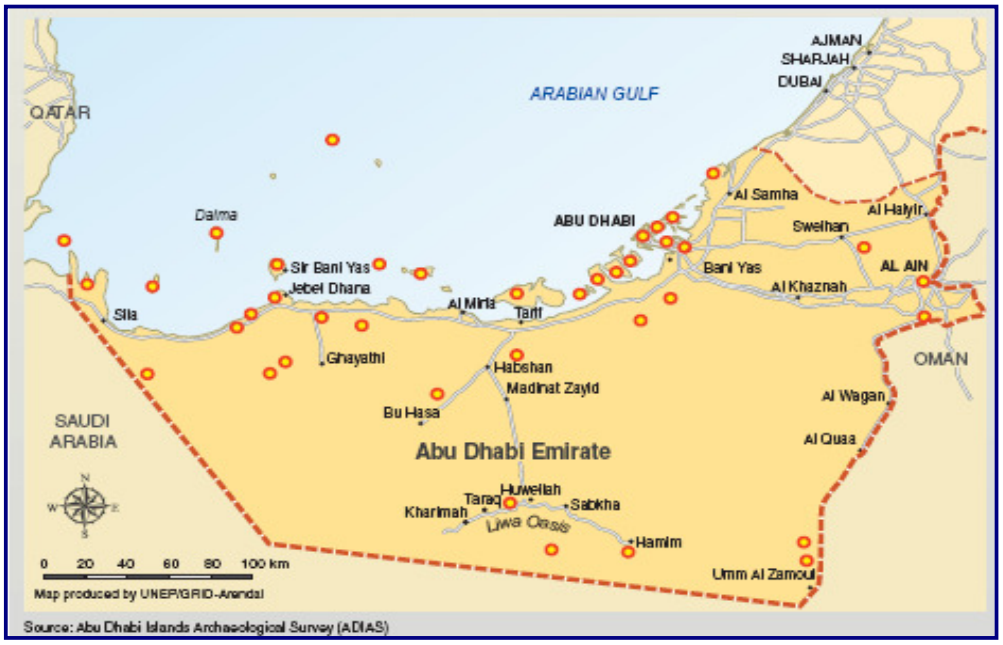

Figure 3.7-1: Major Archaeological Sites in Abu Dhabi

3.8 Social, Recreation and Cultural

The current site does not offer much recreational value in regards to public access, use and enjoyment. It does however provide a service to the agricultural and research organisations. The extent to which this will be re-provided is still to be determined.

The proposed development offers a range of recreational activities including a gym, arena and shops, which will enhance the local facilities for the community and bring new residents, workers and visitors to the area.

The development must ensure that it meets the community expectations, socially and culturally, including meeting housing demands, local community needs such as health facilities, parking, amenity and open space. These elements, amongst others, create a sustainable community and allow for social inclusion.
The site is located near a mosque and the palace gardens. The development may have an indirect impact by increasing the numbers of people using the mosque.

3.9 Resource and Waste Management

Whilst Abu Dhabi possesses plentiful oil and gas resources, the environmental impacts associated with the extraction, production and distribution of these resources are high. Water is a valuable resource in the Emirates and future costs are likely to increase (See Section 3.2).

Materials should be sourced from the local area where feasible to minimise transportations costs (both financial and environmental) and to enhance the local economy. Recycled materials should also be procured.

Waste production within Abu Dhabi is high per capita. The proposed development will increase the levels of waste production during its construction and operation which will need to be managed according to the waste hierarchy.

3.10 Social and Economic – Sustainable Development

Abu Dhabi Emirate's economy has grown by over *15 %* annually in the past *5* years (SOE, *2006*) making it the wealthiest emirate and the region's second largest commercial centre. Oil and gas are the main resources to which this wealth can be attributed and they are expected to last another *100 – 150* years each.

Agriculture has also increased in recent years and in *2003* there were approximately *25,000* farms. Forestry has also increased by nearly *60 %* within *2* years and now occupies approximately *337,000* hectares which are irrigated with recycled waste water (SOE, *2006*).

Tourism is a key component of the Government's plan to diversify the economy from its petroleum base. The Government aims to increase foreign arrivals from *800,000* in *2003* to *3* million by *2015*. The private sector will therefore have a crucial role in delivering infrastructure for tourism development.

The population has experienced a growth of *200 %* in the last *20* years. As of *2005*, Abu Dhabi is estimated to have a population of *1.85* million, with *650,000* in Abu Dhabi City.

The proposed development site can be considered as a strategic site within the centre of Abu Dhabi city and is likely to have a major positive impact on downtown cityscape. It will also provide a tourist attraction. It aims to provide a number of jobs in the retailing, hotel and entertainment facilities boosting the local economy in an area other than oil. It will also provide centrally located residential properties and offices to help alleviate the increasing demand.

4 Potential Environmental Impacts

The table below (4.1) identifies the most significant environmental impacts of the proposed project and the associated effect of this impact described in a matrix.

Table 4.1: Key Environmental Impacts and Associated Impact Matrix of the Proposed Development

Environmental Topic	Baseline Information Reference	Significant Impacts	Impact Matrix
Water	3.2	The levels and quantities of groundwater could increase from the abstraction and dewatering operations from both the construction and operation stages of the development	Indirect
		There will be an increase in water consumption during construction and operational phases of the proposed development	Direct, Long-term
Ecology and Biodiversity	3.3	Direct loss of the local ecological value from the destruction of trees, vegetation and their associated habitats and ecosystems	Direct
		The removal of vegetation and trees could result in erosion	Cumulative
Landscape and Visual	3.4	The proposed development will significantly alter the current townscape from low level urban, open, green landscape space to a high-rise development with large retail/entertainment buildings dramatically changing the visual appearance of the landscape	Direct, Long-term
		The buildings will be dominant features on the sightline	Direct, Long-term
		There maybe an increase in shading, formation of micro-climates and the occurrence of wind tunnels	Undesired, Adverse
Air Quality and Climate Change	3.5	Air pollution levels will increase during the construction phase primarily from dust dispersion and construction traffic	Direct, Short-term
		During the operational phase there will be an indirect increase in air pollutants from local traffic, visitors and servicing	Indirect, Long-term
		There will be an increase in energy consumption during construction and operational phases of the proposed development	Direct, Long-term

Environmental Topic	Baseline Information Reference	Significant Impacts	Impact Matrix
Noise	3.6	Noise and vibration will be generated from various sources during the construction phase including traffic, materials handling and unloading, piling, earthworks and operations of heavy plant	Direct, Short-term
		There will be elevation in noise levels from increased traffic and the retail and entertainment facilities during the operational phase. In particular, late night noise will increase due to the proposed arena, the increase in the number of people and other operations such as air-conditioning units	Direct, Long-term
Archaeology and local heritage	3.7	There are a number of heritage features close to the site including the neighbouring palace and mosque which will need to be protected from disturbance	Indirect, Long-term
Social, Recreation and Cultural	3.8	The proposed development will enhance social and recreational activities and encourage new residents and visitors to the area by providing new facilities such as the arena, shops and gyms	Indirect, Beneficial
		During the operational phase there will be an increase in disturbance to local communities such as traffic congestion, enhanced use of local amenities such as the mosque and health facilities and loss of aesthetics for surrounding low level residential buildings	Direct, Long-Term
Resource and Waste Management	3.9	The proposed development will increase the levels of waste production during the construction and operation which will need to be managed and appropriately disposed	Direct, Long-term
		Direct use of natural resources during the construction phase	Direct, Short-term
Social and Economic – Sustainable Development	3.10	The proposed development represents an excellent opportunity to contribute to Abu Dhabi's continuing economic success by increasing tourism, employment and the availability of residential properties	Indirect, Beneficial

5 Mitigation Measures

A Construction Environmental Management Plan (CEMP) is required by the EAD prior to the construction phase to ensure that potential environmental risks posed by the construction of the development are recognised and mitigation measures are implemented against these risks. There are also a number of environmental assessment methodologies for buildings / developments including LEED (Leadership in Energy & Environmental Design) that determine the sustainability performance of the development by awarding accreditation. Further information on the requirements of CEMP and LEED are specified in Sections 5.1 and 5.2 respectively. The table below (5.1) contains a summary of recommended mitigation measures and relating mitigation tools to avoid reduce or remedy any potentially adverse environmental impacts associated with the development during the construction and operational phases.

Table 5.1: Mitigation Measures Associated with the Key Environmental Impacts for the Proposed Development

Environmental Topic	Impact	Mitigation Measures	Mitigation Tool
Water	Consumption	Water efficiency measures should be implemented such as the capture of waste water for reuse and use of recycled/grey water	Design / LEED
	Drainage	Potential impacts to the levels and quantities of groundwater caused by abstraction and dewatering operations from both the construction and operation stages of the development should be investigated fully prior to development	Design / CEMP
Ecology and Biodiversity	Direct loss of the local ecological value from vegetation removal	A list of the trees to be transplanted from the site is highlighted in Section 8, 8.3. None of the trees will be retained on the site. Enhancement of an ecological site of local or national importance should be supported in order to compensate for loss of ecological value resulting from development of the site.	Design

Environmental Topic	Impact	Mitigation Measures	Mitigation Tool
Landscape and Visual	Complete change of character from a green, pleasant and tranquil environment to a bustling high rise city centre featuring mass entertainment facilities	Where possible, a sense of open space should be maintained. The new buildings should be aesthetically inspiring whilst respecting nearby cultural and heritage features	Design / Tender specifications
	There maybe an increase in shading, formation of micro-climates and the occurrence of wind tunnels	Detailed townscape assessment should be undertaken to ensure that the position of buildings enhances the local townscape to minimise effect such as shading	Design / Tender specifications
Noise	Increase in noise and vibration during the construction phase	Steps will need to be taken to ensure that noise impacts are minimised during the construction phase of the development. These may include measures such as the fitting of noise dampers to plant and the timing of construction operations to ensure disruption to sensitive receptors is minimised. See Table 5.1.1 section 5.1 for further information	CEMP
	Increase in noise and vibration during the operational phase	Noise impacts associated with the operational phase of the development will also need to be mitigated. These could include the sound proofing of the arena, which is likely to be a major source of noise. See Table 5..2.1 section 5.2 for further information	Design / Tender Specifications
Air Quality and Climate Change	Air pollution levels will increase during the construction and operational phases	During construction, measures will need to be incorporated to ensure that air quality impacts are minimised and should form part of the CEMP	CEMP
		The development should also ensure there is appropriate provision for the use of public transport and encourage more sustainable modes of transport such as walking	Design / LEED
	The proposed site facilities such as the accommodation towers, office	In order to assist with the preservation of resources and minimise pollution the use of renewable energies such as	Design / Tender Specifications /

Environmental Topic	Impact	Mitigation Measures	Mitigation Tool
	blocks, retail and the arena will also require significant quantities of energy for operations such as lighting and air conditioning.	solar power should be explored, energy and water efficient designs should be adopted and waste should be minimised and reused.	LEED
Archaeology and local heritage	Disturbance of heritage features close to the site	Consultation with the Abu Dhabi Authority for Culture and Heritage (ADACH) to help identify whether there are any known archaeological or heritage features on or near the site that may be affected	Consultation
Social, Recreation and Cultural	Enhancement of social and recreational activities	Care should be taken to ensure that the development appeals to and is used by as wide a cross section of the community as possible. One way in which this may be achieved is through the incorporation of recreational and community facilities e.g. health facilities, meeting places. Early and effective consultation with the local community will help to ensure that this is the case	Consultation / LEED
		Consultation should also take place with surrounding land users or stakeholders, e.g. local residents, to ensure that potential negative impacts of the development are minimised and any potential positive impacts maximised	Consultation
Resource and Waste Management	Increased levels of waste production during: Construction phase	The proposed development should ensure that resource use and waste production are minimised during the construction phase by following CEMP requirements. This will help to ensure that the development is in accordance with the principles of sustainable development and will also reduce construction costs	CEMP
	Operational phase	The proposed development should ensure that resource use and waste production are minimised during the operational phase by liaising with the Abu Dhabi Waste Management Centre (ADWMC). This will help to ensure that the development is in accordance with the principles of sustainable development and will also reduce construction and operating costs	Design/ Consultation with ADWMC

Environmental Topic	Impact	Mitigation Measures	Mitigation Tool
	Direct use of natural resources during the operation and construction phase	Table 5.3.1 - Section 5.3 provides information on ways in which resource use and waste production could be minimised during the construction phase of the development while Table 5.4.1 - section 5.4 looks at how these aims could be achieved during the operational phase of the development	LEED
Social and Economic – Sustainable Development	Contribution to Abu Dhabi's continuing economic success by increasing tourism, employment and the availability of residential properties	The proposed developed should be designed, constructed and operated in accord with the principles of sustainable development	Design / LEED

5.1 Scope for Construction Environmental Management Plan (CEMP)

As detailed in section 4 the proposed development has the potential to result in a number of environmental impacts during the construction phase. The potential environmental risk posed by major construction projects are recognised by the EAD. The EAD requires that developers and contractors manage these environmental risks through production of a CEMP.

"Major construction projects are important to Abu Dhabi's economic development. During construction, however, such projects pose significant risk to the environment, which must be addressed by developers and contractors. Construction practices that fail to control pollution can cause damage to marine environment, kill fish, upset aquatic ecological systems and wildlife communities, and result in contamination of land and groundwater." (EAD, CEMP Guidance).

The EAD guidance on CEMP goes on to state that environmental risks are particularly high when work is done near residential areas which is the case with the proposed development. The EAD identifies the major environmental risks for projects in built up areas as poor practices resulting in air and noise pollution which may cause annoyance to and affect the health of neighbouring communities.

The EAD has produced a document (Technical Guidance Document – Development of Construction Environmental Management Plan (CEMP) – Onshore) which aims to provide developers and contractors:

- "Information on how to avoid and minimize environmental impact which is preferable to the less cost-effective option of controlling or treating discharges to the environment, or undertaking remedial action.
- Information on the likely impact of construction activities on the environment and how this is to be assessed.
- A clear statement of environmental performance objectives for each segment of the environment.
- Suggested best practice environmental performance measures to meet the performance objectives based on available experience." (EAD, CEMP Guidance).

Production of the CEMP is the responsibility of the main contractor however the developer should seek to ensure that the development is constructed in a way which minimises environmental risk. One means of achieving this is through the production of an Environmental Contractor Specification (ECS) which the contractor must adhere to in production of their CEMP and undertaking of construction activities. An example of the general requirements of an ECS is provided below:

- The contractor shall fully comply with all relevant environmental legislation.
- The contractor shall manage all activities so as to minimise waste, prevent pollution and protect the environment.

- The contractor shall prepare and implement a Construction Environmental Management Plan to be agreed with the site engineer.
- The contractor should preferably have a certified environmental management system e.g. ISO 14001.

Specific requirements can then be added relating to best practice management techniques for the key environmental risks for the construction phase of the project. Table 5.1-1 summarises the key environmental risks of the construction phase of the project and identifies best practice techniques (from the EAD CEMP guidance) for their management which could be included in the ECS as requirements.

Table 5.1-1: Summary of Key Environmental Risks during the Construction Phase and Examples of Best Practice Management Techniques

Environmental Risks	Management Techniques
Erosion	Revegetate and mulch progressively as each section of the works is completed. The interval between clearing and revegetation should be kept to an absolute minimum.
	Program construction activities so that the area of exposed soil is minimised during times of the year when potential for erosion is high.
	Keep vehicles to well defined haul roads.
Dust generation	Prevent dust generation in preference to applying dust suppression measures.
	Pave and water haul roads. The frequency of watering will be determined by wind conditions and the erodability of the soil. If additives in the water are used to increase its dust suppression properties, the chemical should have no adverse impacts on marine bodies.
	Ensure that smooth surfaces are deep ripped and left rough and cloddy to reduce the wind velocity at the soil surface.
Noise nuisance	Limit the times of operation of noisy equipment, vehicles and operations.
	Depending on the location of the facility, suitable noise suppression or abatement measures may be required, such as the provision of noise screens.
	Fitting noise dampers to plant equipment.
Excessive production of waste	Using recycled / grey water for dust suppression and irrigation of vegetation.
	Segregating and recycling solid wastes generated by construction activities, offices and mess rooms.

It is recommended that the ECS is produced in collaboration with the main contractor to ensure that the environmental aims of the development are understood by the main contractor and environmental management practices required by the ECS are achievable.

5.2 Sustainability considerations

There are a number of environmental assessment methodologies for buildings / developments. These include:

- LEED (Leadership in Energy & Environmental Design) – Developed by the United States (US) Green Building Council.
- BREEAM (Building Research Establishment Environmental Assessment Methodology) – Developed by the United Kingdom (UK) Building Research Establishment (BRE).
- Sustainability Checklist – Developed by the UK South East England Development Agency (SEEDA) and the BRE.

These methodologies score the sustainability performance of buildings / developments across a range of categories to enable a rating to be assigned. As well as assessing the sustainability performance of developments which have already been constructed these methodologies can be used to guide developments prior to the detailed design stage.

The United Arab Emirates has established a Green Building Council, the Emirates Green Building Council (Emirates GBC). The Emirates GBC is a member of the World Green Building Council (World GBC).

"The Emirates GBC was formed in July *2006* with the goal of advancing green building principles for protecting the environment and ensuring sustainability in the United Arab Emirates." (www.emirates.gbc.org).

The members of the World GBC have developed a range of rating tools e.g. the US uses the LEED system, the UK uses the BREEAM system. The World GBC web site states that the Emirates GBC is due to launch its rating tool on the *24* June *2007*. The rating tool has not been launched to date so cannot be used for the purposes of this report. However the Emirates GBC website includes details of a number of assessments that have been carried out on developments in the Emirates using the LEED system. For this reason the majority of the following information in this section is drawn from the LEED system, however the developer may wish to look at some of the other tools available to gain a wider understanding of sustainable building practices. The information is specifically drawn from LEED for Construction Version *2.2* (there are a number of different LEED programs, which focus on different sort of buildings / developments).

Table 5.2-1 summarises the key environmental impacts associated with the operational phase of the proposed development along with opportunities that can be implemented to gain LEED accreditation. This is not intended to be an exhaustive list of mitigation measures for each risk rather it is intended to provide examples which can be used to inform more in depth works at the detailed design stage. It should be noted that LEED is currently being adapted for the UAE so that climatic and environmental aspects are considered therefore some opportunities may not be relevant to the proposed development.

Table 5.2-1: Key Environmental Impacts during the Operational Phase of the Proposed Development and Corresponding Opportunities Associated with LEED Accreditation

Environmental Risks	Issues	Opportunities	LEED Reference
Water	Consumption	Perform a soil/climate analysis to determine appropriate plant material and design the landscape with native or adapted plants to reduce or eliminate irrigation requirements. Where irrigation is required, use high-efficiency equipment and/or climate-based controllers.	WE Credit 1.1: Water Efficient Landscaping: Reduce by 50%
		Perform a soil/climate analysis to determine appropriate landscape types and design the landscape with indigenous plants to reduce or eliminate irrigation requirements. Consider using storm water, grey water, and/or condensate water for irrigation.	WE Credit 1.2: Water Efficient Landscaping: No Potable Water Use or No Irrigation
		Specify high-efficiency fixtures and dry fixtures such as composting toilet systems and non-water using urinals to reduce wastewater volumes. Consider reusing storm water or grey water for sewage conveyance or on-site wastewater treatment systems (mechanical and/or natural). Options for on-site wastewater treatment include packaged biological nutrient removal systems, and high-efficiency filtration systems.	WE Credit 2: Innovative Wastewater Technologies
	Site Drainage	Design the project site to maintain natural storm water flows by promoting infiltration. Specify vegetated roofs, pervious paving, and other measures to minimize impervious surfaces. Reuse storm water volumes generated for non-potable uses such as landscape irrigation, toilet and urinal flushing and custodial uses.	SS Credit 6.1: Storm Water Design: Quantity Control
Ecology and biodiversity	Destruction of trees and vegetation	On green field sites, perform a site survey to identify site elements and adopt a master plan for development of the project site. Carefully site the building to minimise disruption to existing ecosystems and design the building to minimise its footprint. Strategies include stacking the building program, tuck-under parking and sharing facilities with neighbours. Establish clearly marked construction boundaries to minimize disturbance of the existing site and restore previously degraded areas to their natural state. For previously developed sites, utilize local and regional governmental agencies, consultants, educational facilities, and native plant societies as resources for the selection of appropriate native or adapted plant materials. Prohibit plant materials listed as invasive or noxious weed species. Native/adapted plants require minimal or irrigation following establishment, do not require active maintenance such as mowing or	SS Credit 5.1: Site Development: Protect or Restore Habitat

Environmental Risks	Issues	Opportunities	LEED Reference
		chemical inputs such as fertilizers, pesticides or herbicides, and provide habitat value and promote biodiversity through avoidance of monoculture plantings.	
Visual impact and landscape	Maintaining a sense of open space	Perform a site survey to identify site elements and adopt a master plan for development of the project site. Select a suitable building location and design the building with a minimal footprint to minimise site disruption. Strategies include stacking the building program, tuck-under parking and sharing facilities with neighbours to maximize open space on the site.	SS Credit 5.2: Site Development: Maximize Open Space
Air quality / Climate Change	Transport related emissions	Perform a transportation survey of future building occupants to identify transportation needs. Site the building near mass transit.	SS Credit 4.1: Alternative Transportation: Public Transport Access
		Design the building with transportation amenities such as bicycle racks and showering/changing facilities.	SS Credit 4.2: Alternative Transportation: Bicycle Storage & Changing Rooms
		Provide transportation amenities such as alternative fuel refuelling stations. Consider sharing the costs and benefits of refuelling stations with neighbours.	SS Credit 4.3: Alternative Transportation: Low Emitting & Fuel Efficient Vehicles
		Minimize parking lot/garage size. Consider sharing parking facilities with adjacent buildings. Consider alternatives that will limit the use of single occupancy vehicles.	SS Credit 4.4: Alternative Transportation: Parking Capacity

Environmental Risks	Issues	Opportunities	LEED Reference
	Off site emissions related to energy consumption / Energy efficiency	Design the building envelope and systems to maximize energy performance. Use a computer simulation model to assess the energy performance and identify the most cost-effective energy efficiency measures. Quantify energy performance as compared to a baseline building.	EA Credit 1: Optimize Energy Performance
		Assess the project for non-polluting and renewable energy potential including solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies. When applying these strategies, take advantage of net metering with the local utility.	EA Credit 2: On-Site Renewable Energy
		Design and operate the facility without mechanical cooling and refrigeration equipment. Where mechanical cooling is used, utilize base building HVAC and refrigeration systems for the refrigeration cycle that minimise direct impact on ozone depletion and global warming. Select HVAC&R equipment with reduced refrigerant charge and increased equipment life. Maintain equipment to prevent leakage of refrigerant to the atmosphere. Utilize fire suppression systems that do not contain HCFCs or Halons.	EA Credit 4: Enhanced Refrigerant Management
		Determine the energy needs of the building and investigate opportunities to engage in a green power contract. Green power is derived from solar, wind, geothermal, biomass or low-impact hydro sources. Visit www.green-e.org for details about the Green-e program. The power product purchased to comply with credit requirements need not be Green-e certified. Other sources of green power are eligible if they satisfy the Green-e program's technical requirements. Renewable energy certificates (RECs), tradable renewable certificates (TRCs), green tags and other forms of green power that comply with Green-e's technical requirements can be used to document compliance with EA Credit 6 requirements.	EA Credit 6: Green Power
Noise	Traffic noise and Entertainment related noise	LEED for Construction Version 2.2 does not include any requirements to reduce the noise impact of developments however potential noise reduction measures include: • Sound proofing of buildings which are likely to be major sources of noise e.g. the Arena. • Fitting noise dampers to noise producing infrastructure e.g. cooling units. • Installation of noise barriers / bunding to shield sensitive receptors	N/A

Environmental Risks	Issues	Opportunities	LEED Reference
		from sources of noise.	
Social, Recreation & Cultural	Creating a sound community base for residents, workers and visitors	During the site selection process, give preference to urban sites with pedestrian access to a variety of services.	SS Credit 2: Development Density & Community Connectivity
Resource and waste management	Minimising use of natural resources	Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.	MR Credit 4.1: Recycled Content: 10% (post-consumer + ½ pre-consumer)
		Establish a project goal for locally sourced materials, and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.	MR Credit 5.1: Regional Materials: 10% Extracted, Processed & Manufactured Regionally
		Establish a project goal for rapidly renewable materials and identify products and suppliers that can support achievement of this goal. Consider materials such as bamboo, wool, cotton insulation, agrifiber, linoleum, wheat board, strawboard and cork. During construction, ensure that the specified renewable materials are installed.	MR Credit 6: Rapidly Renewable Materials
		Establish a project goal for FSC-certified wood products and identify suppliers that can achieve this goal. During construction, ensure that the FSC-certified wood products are installed and quantify the total percentage of FSC-certified wood products installed.	MR Credit 7: Certified Wood
	Increased generation of waste	Coordinate the size and functionality of the recycling areas with the anticipated collection services for glass, plastic, office paper, newspaper, cardboard and organic wastes to maximize the effectiveness of the dedicated areas. Consider employing cardboard balers, aluminium can crushers, recycling chutes and collection bins at individual workstations to further enhance the recycling program.	MR Prerequisite 1: Storage & Collection of Recyclables Required

6 Summary of Findings

6.1 Background

The proposed development site can be considered as a strategic site within the centre of Abu Dhabi city and is likely to have a major positive impact on the cityscape. It will also provide a key tourist attraction. It aims to provide a number of jobs in the retailing, hotel and entertainment facilities, boosting the local economy in an area other than oil. It will also provide centrally located residential properties and offices to help meet the increasing demand.

The site is currently occupied by the Abu Dhabi Municipality, Agriculture Section, and is an agricultural research facility. The site supports the Al Manhal nursery and the Agriculture Research Laboratory. It is covered in trees and plants, some planted, others wrapped in plastic bags for future planting, with a few supporting buildings (administration, staff facilities and water tanks).

6.2 Impacts Summary

The environmental baseline has been determined through an initial desk based study and a site visit. The key impacts identified are:

- **Water consumption:** Water consumption during construction and operation will be high and measures to minimise water usage such as the capture of waste water for reuse and use of recycled or grey water should be implemented.
- **Local ecological importance:** The current ecology on the site can be considered to be of local ecological importance with a number of trees, shrubs and other vegetation which are likely to support some avian species, reptiles and insects. There will be direct loss of this local ecological value from the destruction of trees, vegetation and their associated habitats which could also result in erosion. The tree survey identified *53* trees suitable for retention on the site; *1280* trees to be retained but transplanted to other locations and *580* to be removed. It has been recommended by the Abu Dhabi Municipality that the trees suitable for transplantation can be removed and transported to the nursery of the Public Garden Directive. In order for tree transplantation to be a success and to ensure that the trees survive, the guidelines on tree transplanting in the Tree Survey Report (Section *8*) should be carefully followed.

  There are a further *208* trees within the road corridors surrounding the site which include the UAE native “Ghaf” tree. In the event that these trees do not impact on the development, steps should be taken to retain and protect as many of these trees as possible.

  The development should incorporate an area of open space using the existing mature vegetation and could provide an opportunity for education and raising local awareness. Where this is not possible, enhancement of an ecological site of local or national importance should be supported in order to compensate for loss of ecological value resulting from development of the site.

- **Cityscape:** The proposed development will significantly alter the current character from a green, pleasant and tranquil environment to a bustling high rise city centre featuring mass entertainment facilities. The buildings will be dominant features on the sightline. There maybe an increase in shading, the formation of micro-climates and the occurrence of wind tunnels. These effects should be determined through further assessment as detailed design proceeds.
- **Air Quality and Climate Change:** The proposed development will increase air pollution levels during the construction phase primarily from dust and construction traffic. These should be addressed through the implementation of a CEMP. Significant consumption of energy will be required for operations including lighting and air conditioning for the site facilities such as the accommodation towers, office blocks, retail and the arena. Energy consumption should be sought to be minimised, to facilitate this energy efficiency measures must be incorporated within the design of the building.
- **Noise:** Construction will generate noise and vibration from numerous sources. These will include traffic, materials unloading and handling, piling, earthworks and operation of heavy plant. These should be addressed through a CEMP. There will be elevation in noise levels from increased traffic and the retail and entertainment facilities during the operational phase. In particular, late night noise will increase due to the proposed arena, the increase in the number of people and other operations such as air-conditioning units. Mitigation could include sound proofing the arena.
- **Social, recreation and cultural:** The current site does not offer much recreational value in regards to public access, use and enjoyment. It does however provide a service to the agricultural and research organisations which will need to be located. The new development offers a range of recreational activities including a gym, arena and shops which will enhance the local facilities for the community and bring new residents, workers and visitors to the area. The development must ensure that it meets the community expectations, socially and culturally, including meeting housing demands, local community needs such as health facilities, parking, amenity and open space. These elements, amongst others, create a sustainable community and allow for social inclusion.
- **Socio-economic:** The proposed architecture may increase surrounding land values by enhancing the city environment with iconic design features, increased facilities, plazas etc. improving the character of public realm and creating new tourist attractions. Building for sustainability will ensure long-lasting success.

6.3 Next Steps

The EAD will review this PER and in turn make an informed decision on whether further environmental assessments such as a TOR or EIA are required. On initial discussions with the EAD, it was deemed unlikely that further formal assessments be required. On approval of the PER a Construction Environmental Permit will be issued by the EAD.

7 References

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8 Tree Survey Report

8.1 Introduction

8.1.1 Project Overview

Mouchel has been commissioned to investigate the location and quality of approximately *2000* trees that occupy a substantial part of the Al Mashtal development site. This site is currently one of the few vegetated spaces within the city and it is recognised that some of the tree species on site are of a considerable size.

As part of the assessment process a two-day site survey was carried out on *17th – 18th* October *2007*. Data was recorded on the tree species and their size and condition.

A local plant nursery, Irrigation Trade Middle East (ITME), are specialists in tree transplantation in the UAE and assisted Mouchel with the survey work and provided recommendations for suitability of trees for transplanting.

8.1.1.1 Site Area

The nursery site occupies an area of *13.5* hectares and is dissected into three smaller sites by two tarmac roads. For the purposes of this report the sites will be referred to as:

- Site 1: South Site.
- Site 2: Centre Site.
- Site 3: North Site.

All three sites are bounded by high walls and are closed to the general public. Access to the sites for the *2*-day survey work was granted by the client.

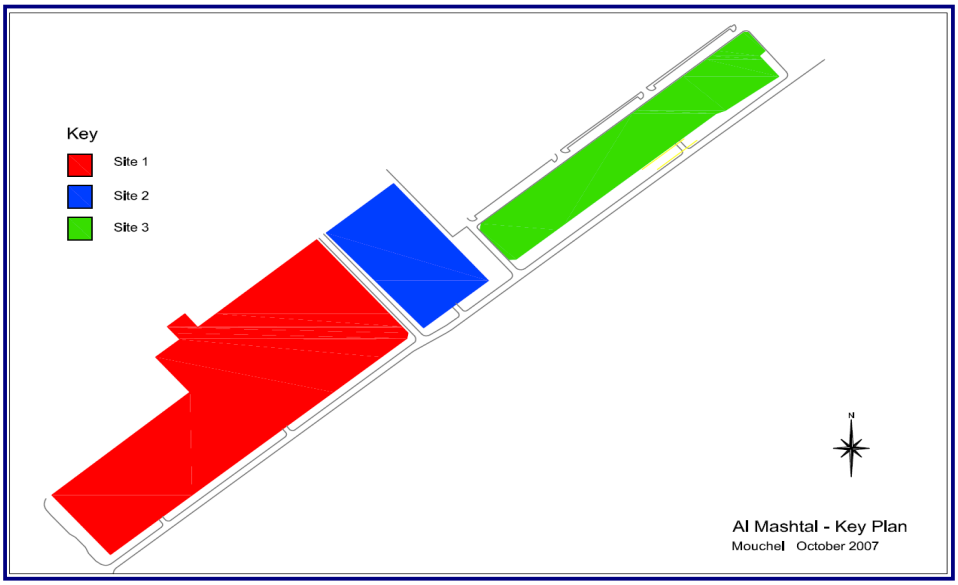

Figure 8.1.1.1-1: Key Plan of Site

8.1.1.2 History of the Project

Sorouh Real Estate is planning to develop a mixed-use scheme on the site, known as Al Mashtal, which consists of residential, retail, office and entertainment elements as well as a 5,000 capacity arena.

8.1.1.3 The Purpose of the Report

The aim of the report will be:

- To provide a summary of the location, species and condition of trees on site;
- To determine suitability of particular trees for retention;
- To determine suitability of particular trees for transplanting;
- To recommend the methodology for the preparation of trees for transplanting;
- To recommend methodology for the protection of trees during Construction.

It is recognised that this survey and report has been carried out after preliminary site layouts have already been formulated. However this tree survey has been carried out objectively and without reference to site layout plans.

The report will not detail how the proposed concept design of the development will be effected by the location of the existing trees, and will not at this stage make recommendations on how specific trees might be accommodated into the development.

8.1.2 Survey Methodology

The survey was completed by persons experienced in UAE arboriculture, and was carried out visually from ground level. As no detailed topographical survey of the site existed at the time of the survey the tree stem positions were estimated using site features such as roads, walls and buildings shown on existing plans and aerial photos of the site. A survey of the underground condition of the root systems was not completed.

A table, which accompanies the plans and lists all the tree species and numbers of trees present on site, is included in *Appendix 1*.

Finally, each species of tree was also measured. An average age, height in metres, branch spread and diameter of the stem of each tree species was recorded on site.

8.2 Project Description

8.2.1 Description of the Proposed Project

The Al Mashtal project aims to create a landmark mixed-use development in the centre of Abu Dhabi combining iconic architecture, communal urban fabric and sustainable development with leading green practices.

Figure 8.2.1-1: View of Proposed Al Mashtal Development (taken from 2462 Concept Design Report)

8.2.2 Project History

The development site is the former nursery of the Manhal Palace, the official residence of Sheikh Zayed bin Sultan Al Nahyan until *1974*. The site is currently occupied by the Abu Dhabi Municipality and is an agricultural research facility. The site supports the Al Manhal Nursery and the Agriculture Research Laboratory.

Figure 8.2.2-1: Existing Al Manhal Nursery Entrance

Figure 8.2.2-2: View within the Al Manhal Nursery

8.2.3 Site Overview

8.2.3.1 Location

The Al Mashtal development site is located in the centre of Abu Dhabi Island, just off Airport Road. It is situated opposite the Manhal Palace and there are plans to refurbish the Palace and its associated garden into a national museum.

There are also numerous offices and residential accommodation that overlook the site as well as a number of retail and restaurant facilities. There is a mosque just outside the site boundary.

8.2.3.2 Environment

The site contains a large number and variety of trees, shrubs, and other vegetation including succulent plants. The flora also supports a number of avian species, evident during the site visit. The site is not open to the public but it is one of the few open, vegetated spaces within the city.

The late president Sheikh Zayed bin Sultan Al Nahyan was a conservationist who undertook extensive plantations in both private reserves and the open desert. It is likely that many of the trees in the nursery site were species specifically grown by him.

8.3 Tree Survey Findings and Recommendations

8.3.1 Overview of Tree Species across the Site

In all *2000* trees were surveyed on all three of the sites. *36* species of tree were identified and descriptions of these can be found in Appendix 1.

8.3.1.1 Site 1

This site contains by far the largest number of specimen trees. The trees found in this area are also some of the largest including 'Terminalia arjuna', 'Tamarindus indica', and 'Terminalia catapa'. All three species are attractive 'park' trees and of a significant and mature size. The southern end of the site has *3* Terminalia arjuna trees that are over *30m* high.

Figure 8.3.1.1-1: Mature Trees in Site 1

Figure 8.3.1.1-2: Tamarindus Indica in Site 1

8.3.1.2 Site 2

The majority of the trees on this site are fruit trees, (Olive, grapefruit, fig and banana). These varieties of tree are smaller in size than those found in site 1.

There are also larger more ornamental trees in this site - a plantation and avenue of Zizyphus jujuba and a plantation of Olea europaea. A large plantation of grapefruit trees dominates site 2.

Figure 8.3.1.2-1: Musa Plantation in Site 2

8.3.1.3 Site 3

Similar to Site 2 the majority of this area is planted up with rows of fruit trees.

Large grapefruit plantations take up the majority of the area. Several date palms line the central track. In addition to the olive and grapefruit plantations there is also an area dominated by rows of Tamrindus indica and the northern corner of the site contains mainly Manilkara zapota.

Figure 2.3.1.3-1: Manilkara Zapota, found in Site 3.

8.3.1.4 Outside Boundary

There are a considerable number of trees located within the wide road corridor around the boundary of the site. In places there are double rows of trees lining the site boundary wall. The species that dominate these areas include Moringa oleifera, Zyzyphus spina christi and Prosopis cineraria. All *21* of the Prosopis cineraria, Ghaf trees, have been categorised as 'Type A'

Figure 8.3.1.4-1: Eastern Boundary of Site 3

8.3.2 Tree Categorisation

As mentioned in Chapter 1, each tree species on site was classified into one of 4 categories. The purpose of tree categorisation is to identify the quality and value of the existing tree stock. These categories are described below:

8.3.2.1 Type A

These are the trees with the highest landscape quality and value that make a substantial contribution to the landscape and in most cases have a minimum age of 30 years. They are trees that are particularly good examples of their species, especially if rare or unusual and form distinct landscape features. They are generally 10-30m in height and due to their size and age these trees are unlikely to survive if transplanted.

8.3.2.2 Type B

These are trees with moderate quality and value. They are of considerable size (generally 2-10m high) and make a significant contribution to an ornamental formal or semi-formal setting. They consist mainly of date and coconut palms and are widely used in park and streetscape schemes in the UAE. These trees are suitable for transplanting.

8.3.2.3 Type C

These trees are also of a considerable size (*2-10m* high) and therefore high arboriculture value but as they are mostly fruit trees they have a limited landscape value. These species are not usually used for ornamental purposes. These trees can however be easily transplanted and sold to a nursery or farm.

8.3.2.4 Type D

These are the trees with the lowest landscape quality and value as they are commonly occurring species that are generally used for functional reasons rather than aesthetic. They are fast growing species used as wind breaks, screening or for industrial purposes.

8.3.3 Recommendations

Existing trees of good quality and of appropriate species and positions can greatly enhance and add to the quality of a new development and increase property values. Mature trees provide an immediate appearance of maturity and permanence and vertical interest. They provide much needed shelter from extremes of heat, purify the air and harbour wild life and generally benefit everything living in their immediate vicinity, not just ourselves.

A long time is required for a tree to reach maturity and a tree may stand in one place for *100* years. Therefore great thought must be given to the future of the mature trees on site and it is important to identify these trees early in the planning process. It is recommended that Type C and D trees are transplanted where possible; none of the trees will be retained on the site.

Lists of the trees that will be removed and transplanted to another nursery are highlighted in the table below:

Table 8.3.3-1: List of Trees to be Transplanted from Mashtal Manhal

Item	Name	Quantity
1	Citrus aurantifoha	21
2	Citrus limmetiodes	6
3	Citrus maxima	2
4	Citrus paradisi	9
5	Citrus reticulata	13
6	Citrus sinensis	5
7	Cocos nuclfera	107
8	Ficus carica hortensis (Red)	28
9	Ficus carica hortensis (White)	4
10	Mangifera indica	11
11	Morus alba(Red)	19
12	Morus alba(White)	10
13	Oleaeuropea	46
14	Phoenix dactyhfera	33
15	Psidium guajava	7
16	Washingtonia filiferra	2
17	Zizyphus spina-cristi	11
TOTAL		**334**
Some shrubs like Jatrophajhevitia, Bougainvillea spp, Jasminium grandiflora and Nertum oleander can be shifted in pots to use as Mother plant (100 nos:)		

8.4 Tree Transplanting

8.4.1 Introduction

Trees can be successfully retained on development sites by working to appropriate standards. The following paragraphs will highlight the key issues to consider when retaining a tree on site.

As identified in the previous chapter opportunities also exist to transplant inappropriately positioned good quality trees to new locations. Only trees of a certain size and species are appropriate for transplanting and these have been identified in the tree survey. Paragraph *4.3* will highlight the measures that need to be taken to prepare the tree for transplanting. In most cases sufficient time must elapse between preparation of the root ball and final lifting to allow for the development of new roots capable of sustaining and continuing the growth of the transplanted tree. Therefore decisions on the future of the trees need to be made as early as possible in the design development of the site.

8.4.2 Tree Protection

In order to avoid damage to the roots or rooting environment of retained trees the root protection area (RPA) should be plotted around each of the trees.

This is a minimum area in m^2 which should be left undisturbed around each retained tree. The RPA is calculated as an area equivalent to a circle with a radius 12 times the stem diameter.

All trees retained on site should be protected by barriers and or ground protection. For guidance on erecting barriers and ground protection refer to '*BS 5837:2005* 'Trees in relation to Construction, chapter 9'.

Once the exclusion zone has been erected the following should also be addressed:

- Care should be taken when planning site operations to ensure that wide or tall loads or plant equipment does not come in direct contact with the retained trees;
- Material which will contaminate the soil, e.g. concrete mixings, diesel oil and vehicle washings, should be discharged within *10m* of the tree stem.
- Fires should not be lit in a position where their flames can extend to within 5m of foliage or branches;
- Notice boards, telephone cables or other services should not be attached to any part of the tree.

Where it is intended to undertake demolition or construction operations within the root protection area, precaution should be taken to maintain the condition and health of the root system:

- Prevent physical damage to the roots during demolition or construction (such as by soil compaction or severing);
- Make provision for water and oxygen to reach the root system;
- Preserve the soil structure as a suitable bulk density for root growth and function;
- Hand held tools or appropriate machinery should be used (under arboricultural supervision) where an existing surface is scheduled for removal with the RPA.

Before commencing work the contractor should prepare a 'Tree Protection Plan' which outlines the protection measures that he will take when working around existing trees. For more detailed information on protection techniques and construction work adjacent to existing trees refer to '*BS 5837:2005* Trees in relation to construction'.

8.4.3 Tree Transplanting Schedule

Trees that have been selected as suitable for transplanting on this site can only be transplanted after a period of preparation by both root and crown development pruning. A special method must be employed for transplanting these mature trees and carried out by professionally qualified and experienced staff.

Trees should be individually selected for transplanting. A trench approx 300mm x 750mm deep (dependent on the species and soil characteristics) shall be excavated around the roots to create the root ball. The area surrounding the roots shall be filled with 'cocopeat' or 'petemoss' and this shall be secured tightly using special nylon bags. It is then watered at the site

until new roots are developed. After the new roots have developed the main root shall be cut off and the tree shall be moved to a nursery for replanting.

Special hormones and vitamins shall be used for this operation. Ideally preparation should be carried out over two growing seasons by preparing alternative segments in successive years.

Transplanting should be carried out during the dormant season for the particular species. This is normally during the winter months. Ideal conditions are when the weather is dull and ground moist and workable.

Trees should be handled and lifted by the root ball only. Lifting should be direct lift, with padded protection for the tree, using an appropriate machine.

Where a tree cannot be planted as soon as it is delivered, it should be stored upright, in a position where it will be protected from damage and unnecessary movement. Throughout the period of storage the root ball should be protected from drying out.

8.4.4 Next Steps

As and when landscape design proposals are drawn up for the development site it will be useful for the project landscape architects to refer to this report to ascertain what trees species can be utilised within the new landscaping scheme. It is recommended that the trees suitable for retention and transplantation are relocated to another nursery where possible.

8.4.4-1: Tree Species and Numbers

Species No.	*Tree Species*	No. inside boundary	No. outside boundary	Common Name	Category Grading	Comments
1	*Millingtonia hortensis*	22		Cork tree	C	Well established
2	*Olea europaea*	106	8	Olive tree	C	
3	*Jacaranda mimosifolia*	3			C	Well established
4	*Azadirachta indica*	12		Neem tree	D	Well established
5	*Terminalia catappa*	14	2	Indian almond	A	Well established
6	*Tamarindus indica*	40		Tamarind	A	Well established
7	*Terminalia Arjuna*	10		Banyan tree	A	Well established
8	*Cocos nucifera*	60		Coconut palm	B	
9	*Phoenix dactylifera*	115	18	Date palm	B	
10	*Tabebuia rosea*	9		Apama	B	
11	*Conocarpus lancifolius*	23		Button mangrove	D	
12	*Ficus religiosa*	5		Bo tree	C	
13	*Cordia myxa*	4		Assyrian plum	C	Fruit tree
14	*Pithecellobium dulce*	89		Manila tamarind	D	Fruit tree
15	*Morus nigra*	70		Mulberry	C	Fruit tree

16	*Manilkara zapota*	65		Chico	C	Fruit tree
17	*Citrus*		6	Lemon	C	Fruit tree
18	*Citrus paradisi*	325		Grapefruit	C	Fruit tree
19	*Zizyphus jujuba*	145		Jujube	C	Fruit tree
20	*Zizyphus spina christi*	20	115	Christ thorn tree	C	Fruit tree
21	*Artocarpus heterophyllus*	1		Jackfruit	C	Fruit tree
22	*Moringa oleifera*		3	Drumstick	D	
23	*Albizzia lebbeck*	98		Rain tree	D	
24	*Acacia farnesiana*	6		Mimosa bush	C	
25	*Musa paradisica*	84	9	Banana	B	
26	*Thespesia populnea*	65		Aden apple	D	
27	*Schinus molle*	56		Pepper tree	D	
28	*Casuarina equisetifolia*	86		Whispering pine	D	
29	*Eucalyptus camaldulensis*	92		Red gum	D	
30	*Mangifera indica*	67	6	Mango	C	Fruit tree
31	*Psidium guajava*	12		Guava	C	Fruit tree
32	*Ficus Benghalensis*	5		Banyan tree	C	
33	*Fig Fruit trees*	104	8	Fig	C	Fruit tree
34	*Delonix Regia*	8		Flame of the forest	C	
35	*Cordia Sebestina*	7			C	
36	*Prosopis Cineraria*	26		Ghaf Tree	A	